

Relative atomic mass

4.1.1.6 · Atomic structure and the periodic table · revision notes

Relative atomic mass (A_r) is an average value for the atoms of an element that takes account of the abundance of each of its isotopes. You must be able to calculate it from percentage abundances: a common 2 to 3 mark calculation.

Key facts

- A_r = average value for an element's atoms, taking account of the abundance of its isotopes
- A_r has no units
- Chlorine: 75% chlorine-35 + 25% chlorine-37 gives $A_r = 35.5$
- A_r = sum of (mass number $\times$ % abundance) $\div$ 100
- A_r is nearer to the mass number of the most abundant isotope

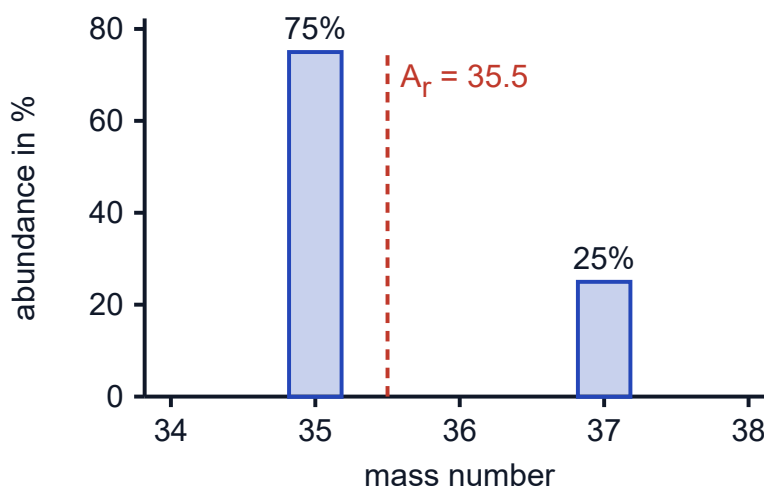
Notes

What relative atomic mass means

- Many elements exist as a mixture of isotopes, which have different masses.
- The **relative atomic mass** (symbol A_r) of an element is an **average** value that takes account of the **abundance** (the percentage of atoms) of each of its isotopes.
- A_r is the number shown for each element in the periodic table on the data sheet, e.g. chlorine 35.5. It has no units.
- A_r is often not a whole number, because it is an average. It is closer to the mass number of the more abundant isotope.

Calculating A_r

- $A_r = (\text{mass number} \times \% \text{ abundance of the first isotope} + \text{mass number} \times \% \text{ abundance of the second isotope} + \dots) \div 100$
- Worked example: chlorine is 75% chlorine-35 and 25% chlorine-37.
 $(35 \times 75) + (37 \times 25) = 2625 + 925 = 3550$
 $3550 \div 100 = 35.5$



A_r of chlorine is 35.5: nearer to 35, the more abundant isotope.

- Sense check: the answer must lie between the smallest and largest mass numbers, and nearer to the mass number of the most abundant isotope.
- If you are given the number of atoms of each isotope instead of percentages, divide by the total number of atoms instead of by 100.

How to answer each type of question

Calculate relative atomic mass from two isotopes

2 marks

Grade 5

- Multiply each mass number by its percentage abundance.
- Add the results.
- Divide by 100 and round as the question asks.

Example. Copper has two isotopes: copper-63 (69%) and copper-65 (31%).
Calculate the relative atomic mass of copper. Give your answer to 1 decimal place.

Model answer. $(63 \times 69) + (65 \times 31) = 4347 + 2015 = 6362$ (1)
 $6362 \div 100 = 63.6$ (1)

Don't lose marks

- ✗ Dividing by the number of isotopes (e.g. by 2) instead of by 100.
- ✗ Adding the mass numbers and halving, which ignores the abundances.

- ✗ Rounding part-way through the calculation, or giving the wrong number of decimal places.
- ✗ Giving A_r units such as grams.

More tips

Memory tricks

- Sense check: A_r must lie between the lightest and heaviest mass numbers.
- If two isotopes are 50% each, A_r is exactly halfway between their mass numbers.
- Type it in one go with brackets to avoid rounding errors: $(35 \times 75 + 37 \times 25) \div 100$.
- For a real element, compare your answer with the A_r in the periodic table: it should be very close.

Exam technique

- Write out the whole expression before you calculate, so you earn the method mark even if you slip on the arithmetic.
- Give the answer to the number of decimal places the question asks for (often 1 decimal place).
- In 'explain' questions about A_r , use the key words: average, isotopes, abundance.

What each grade needs

What you need to be able to do, from the first marks up to the top grade.

Grade 4

Explain what relative atomic mass means

An average value for the atoms of an element that takes account of the abundance of each isotope.

Grade 5

Calculate A_r for two isotopes

Multiply each mass number by its percentage abundance, add the results, then divide by 100.

Grade 5

Explain why A_r is rarely whole

It is an average of isotopes with different mass numbers, weighted by how common each one is.

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